



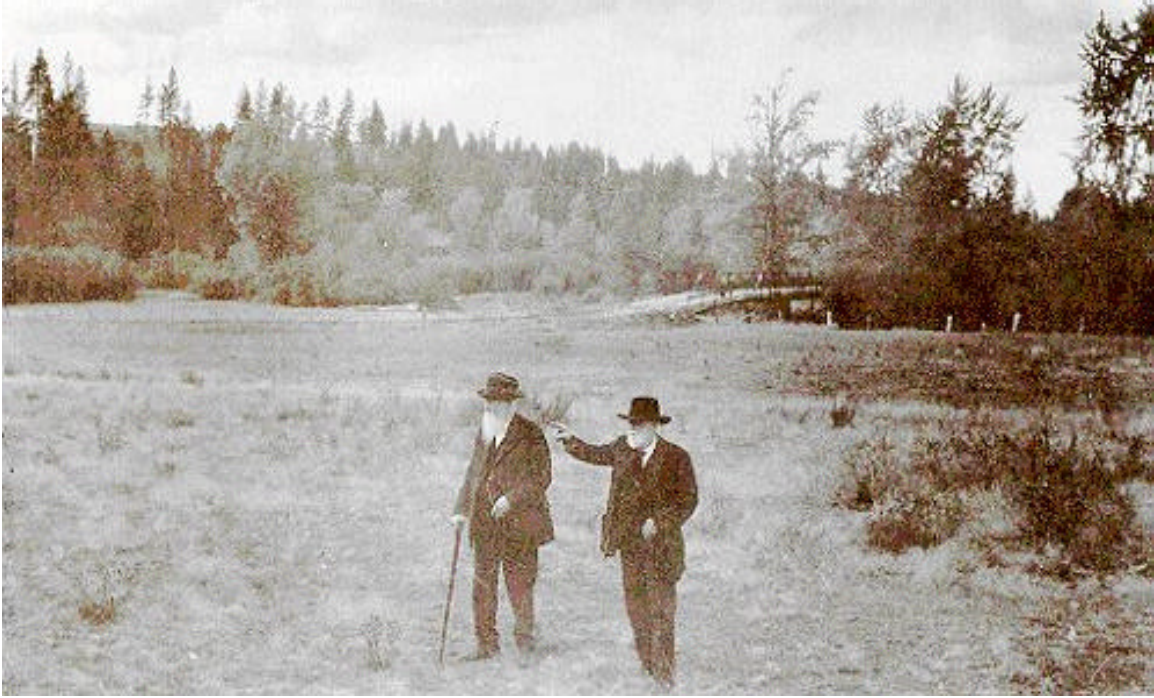
The Hangman (Latah) Creek Water Resources Management Plan

APPENDICES

May 19, 2005

Appendix J

Historic Vegetation Report



Pre-Settlement Vegetation of the
Hangman Creek Watershed
(DRAFT)

June 26, 2003



Sponsored by

The Spokane County Conservation District

*The Hangman Creek Watershed Planning Unit
(WRIA 56)*

Introduction and Background Information

The degraded water quality observed throughout the Hangman Creek watershed raises questions regarding the historical conditions of the watershed. The water quality problems associated with high peak flows and low summer flows compound the water quantity issues in the watershed. There is a common perception that summer water levels were significantly higher in the past, but have fallen throughout the 20th century due to human impacts in the watershed. This investigation provides an assessment of the historic condition of the native vegetative cover and estimates how changes in land use throughout the watershed have influenced the overall water availability and soil loss.

Pre-settlement watershed conditions were evaluated using historic plant community cover as described in early section line surveys. The section line surveys were part of the Public Land Survey System (PLSS) conducted under standards set forth in the 1785 Land Ordinance (BLM, 2003). The rectangular survey system, also known as the cadastral survey, subdivided public lands into townships, ranges, and sections across the western United States.

The original land surveys of Washington were conducted by the Surveyor General's Office in Olympia, WA during the late 19th Century. Similarly, surveys of the Idaho portions of the watershed were supervised by the Surveyor General's Office in Boise, ID in the early 20th Century. Copies of the surveyor notes and plats (maps) are stored at the Cadastral Survey's office on microfiche at Bureau of Land Management regional offices throughout the United States.

Surveys established each Township into six-mile squares. Each township has 36 square miles, and each square mile is called a Section. Surveyors walked each six-mile township boundary line and each one-mile section line. They recorded observations in their field notes, and drew plats and designated boundaries along the line walked. In general, most surveyors' field notes included descriptions of vegetation, landforms, soil type, water availability, and suitability for settlement. These qualitative descriptions of vegetation found in the field notes, along with the hand drawn plats, were used to estimate the historic vegetation cover for the Hangman Creek watershed. The information from the original PLSS was gathered and processed in ArcView 3.2 GIS.

Native vegetative cover in the watershed was once a combination of various shrub/steppe and forested habitat types. These habitat types were described by Daubenmire (1942, 1970) and Daubenmire and Daubenmire (1968). The Palouse bioregion, which composes those plant communities indicative of forming on loessal soils, is now listed as one of most endangered ecosystems in the United States. The onset of settlement in the Palouse region of southeast Washington has resulted in widespread conversion of native prairie and forested lands to agriculture (Black et. al.). This conversion has resulted in the loss of wildlife habitat and native biological diversity for the region.

Alteration of land cover combined with other cumulative effects has contributed to water quality concerns and may directly influence the water availability in the watershed. For example, forest removal can increase peak flows and contribute to valley flooding (EPA,

1991). Activities such as channelization, removal of riparian vegetation, grazing, road building and increasing urbanization has influenced the water quality and quantity.

Hangman Creek has been listed on the Washington State Department of Ecology 303(d) list of impaired waterways for exceedences of high temperature, pH, and fecal coliform bacteria. These water quality issues are further influenced by high sediment concentrations from nonpoint sources, lack of adequate riparian vegetation cover, and extremely low summer flows (SCCD, 1994).

The degradation in water quality raises questions about the historical conditions of the watershed. Based on accounts from Native Americans and early settlers, the watershed at one time supported a salmon fishery. Recent federal Endangered Species listing of five native salmonids found in Washington waterways has the restoration of fish habitat throughout the Northwest a top priority. After the completion of the Grand Coulee Dam in 1942, anadromous salmon were no longer able to migrate and spawn in Hangman Creek. However, recent studies by Eastern Washington University have located small populations of resident redband trout in the tributaries of Hangman Creek. This finding, coupled with the changes in peak floods and low summer flows, brings added attention to water quantity issues in the watershed. There is a common belief that water levels have fallen due to human impacts in the watershed. This report provides an assessment on the historic condition of the native vegetative cover.

Assumptions necessary to use the PLSS

The information contained in the PLSS is qualitative and was sometimes difficult to interpret. Surveyors often used different terminology to describe common plant species and other observations. The vegetative communities and individual species listed in the notes often required interpretation because the surveyors did not use uniform vegetation information. The surveyors did not typically provide detailed accounts of species abundance or use scientific names. Loose terminology, and/or vernacular were often used to describe vegetation. Similarly, handwriting on both the plats and in the notes was sometimes not very clear.

The Washington State surveys ranged from 1869 to 1880, and are considered by the BLM to be the first official surveys for the area. It was assumed that the vegetation observed by surveyors was native and that the conversion to agriculture and the introduction of non-native plants was not yet widespread. Settlements were cited as early as 1870, but the largest farm recorded at that time was approximately 55 acres in T 25 N, R 42 E, sec. 23 & 26.

The earliest reliable Idaho State surveys available for this project ranged from 1903 to 1906. Earlier Idaho surveys were considered fraudulent by the BLM. Settlement was widely expanding into Idaho by this time. Inferences of historical vegetative communities were based on topography and available field notes describing the surrounding landform and plant species. The GIS maps reflect some settlements in Washington, whereas the Idaho settlements were changed to estimates of the original vegetation.

Vegetative Community Delineation

Vegetation types described by the surveyors were categorized into seven major groups based on plant communities and dominant landforms. The categories included:

- Bunchgrass prairie
- Open Ponderosa pine and grasses
- Open Ponderosa pine on rocky surface
- Wetland or lake
- Evergreen forest
- Cottonwood, alder, or willow groves
- Cultivated

In most cases, surveyors wrote a summary labeled “General Description” for each section. The general descriptions, notes, and plats were used to assign the plant community type for each section. The vegetative communities in each section were adjusted using the features and landforms on the surveyor’s plat. GIS tools were utilized to produce a historical vegetation map (Figure 1) and to calculate the area of each vegetative community. These areas were further divided into five sub-watersheds (Table 1) to re-calculate a historical water balance similar to the work conducted by Buchanan and Brown (2003).

Table 1: Historic Vegetation Coverage for the Hangman Creek Watershed

Vegetation Types	Vegetation Area by Sub-watershed (acres)					
	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	Watershed Total
Bunch grass Prairie	110,236	13,650	8,999	33,257	662	166,803
Open Ponderosa Pine with grasses	32,295	24,175	22,798	40,365	8,554	128,186
Open Ponderosa Pine on rocky surface	3,583	4,058	6,546	239	449	14,875
Wetland or Lake	0	645	1,995	0	0	2,640
Evergreen Forest	67,976	2,734	0	39,821	6,276	116,796
Cottonwood, alder, or willow groves	172	570	0	908	0	1,650
Cultivated	135	114	22	0	0	271

Notes:

- Several categories, such as wetlands and lakes, were not originally recorded within several sub-watersheds. This may be a result of details provided by different surveyors and does not infer that they did not exist.
- The bunchgrass prairie vegetative cover included areas defined as shrub steppe.

Methods

Interpreting the PLSS

Interpreting handwriting and terminology was difficult at times. For example, many recorded what they called “sunflowers”. These were most likely *Balsamorhiza sagittata* or arrowleaf balsamroot. Despite the vague and obscure descriptions, the size and species of important overstory trees were recorded. The overstory trees included two trees at each quarter section marker and section corners, trees that served as guide trees for directional bearings, and any trees directly on the section line. This provided the dominant species for an area and possible habitat types and plant associations. In addition to vegetation descriptions, other landmarks such as “Indian” trails, pioneer roads, creeks, springs, settlements and farms were recorded and labeled on the plats.

Since surveyors used non-uniform descriptions for the vegetation, the interpretation of observed species was based on plant names provided by the surveyors and referenced to their occurrence for a given habitat type found in the area as described by Daubenmire (1970). Names given to a plant not found in this region were correlated to a local species within the same genus or family. Such was the case for “buck brush”, a common name for a species found in the South and Midwest United States of the same genus as the common snowberry (*Symphoricarpus albus*). A species list, interpretation of terms used for the plant observed by surveyors, and comments relating to the plants observed can be found in Table 2.

Water Balance

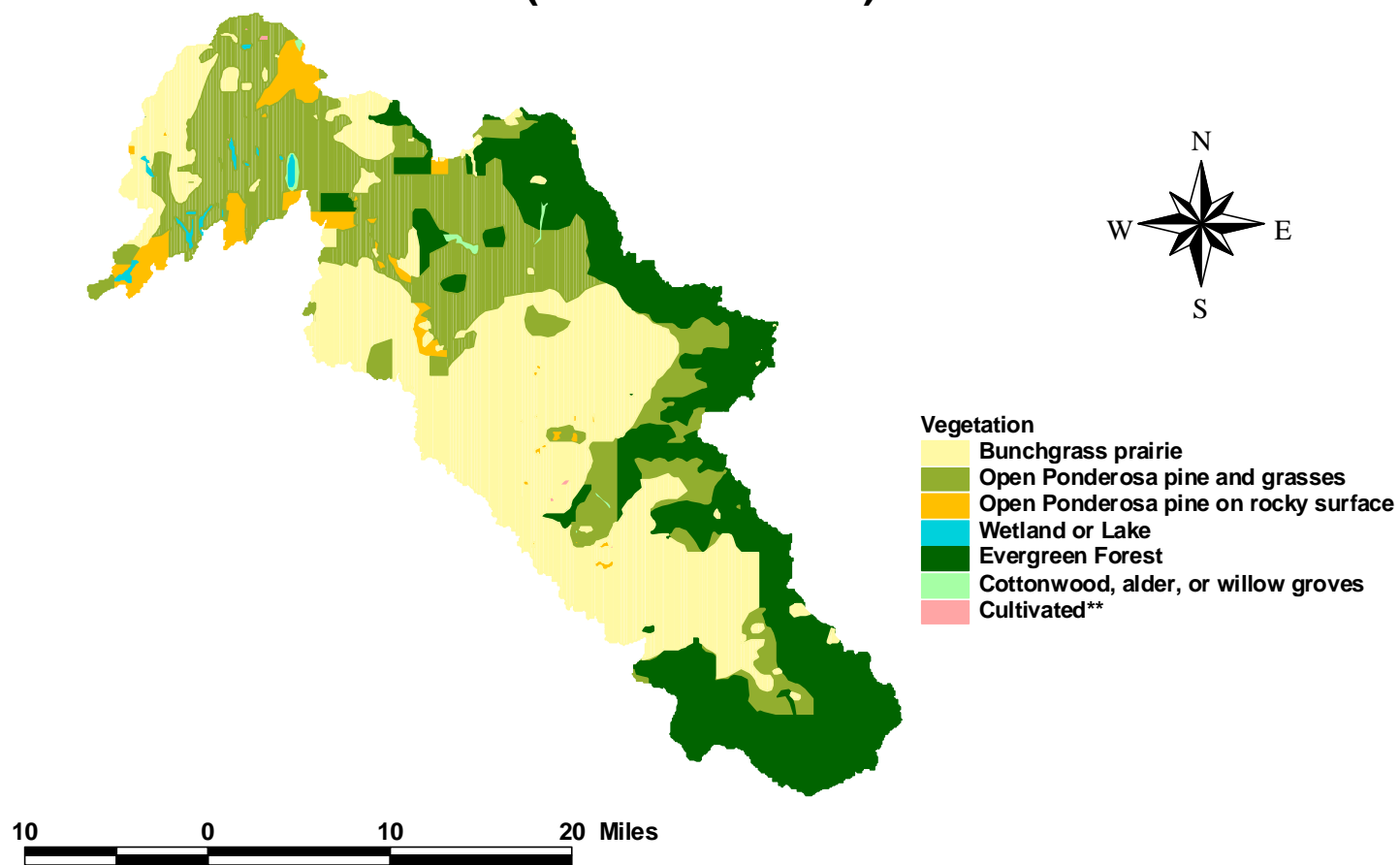
The current water balance for the Hangman Creek watershed incorporated precipitation and ET rates for existing vegetation based on land uses supplied by the USGS. The water balance provided an estimate of how much water (surplus) is available for infiltration to groundwater systems or as surface run-off measured by the USGS. A surplus of 192,854 acre-feet per year was estimated for the entire watershed using data provided by Buchanan and Brown (2003). The same method was then used to predict a water balance for pre-settlement conditions using the historic vegetation map. Table 3 lists the vegetation categories and the corresponding ET values that were used in the historic water balance.

Results and Discussion

Pre-settlement Vegetation Cover

The map in Figure 1 represents the estimated vegetative cover for the Hangman Creek watershed prior to mass settlement. Large changes have occurred in the conversion of prairie/grasslands and open Ponderosa pine communities to agriculture. Table 4 lists the total acres by vegetation types for each sub-watershed based on the PLSS.

Pre-settlement Vegetation Cover of Hangman Creek Watershed (based on PLSS)



** Washington only

Figure 1.0

The historical vegetative communities in the Hangman Creek watershed prior to settlement were significantly different than today (Table 5). The watershed was primarily covered with rolling hills of bunchgrass prairie that extended into scattered populations of Ponderosa pine (*Pinus ponderosa*) forests. The Ponderosa pine communities often included a shrub understory such as snowberry (*Symphoricarpus albus*) and wood's rose (*Rosa woodsii*).

Table 2: Public Land Survey Terms and Descriptions

Original Vegetation Type	Description	Comments
Rolling prairie	Native bunchgrasses with or without shrubs	Surveyors often used the term “rolling prairie” to describe rolling grasslands that were easily cultivated and often cited “prairie soil”, “1 st rate soil”, or “black loam”, thus indicating prairie/grasslands.
Open Ponderosa pine	Open or scattered stands of Ponderosa pine with variable understory of grasses, shrubs, and herbs	Surveyors used the term “Yellow Pine” and often referred to these areas as “scattering timber”.
Open Ponderosa on rocky substrate	Open Ponderosa pine on rocky scabland	Surveyors often referred to this area as “scattering timber and rocky”. It is delineated from the Open Ponderosa pine vegetation type because it was not farmable and considered to be “grazing land” and not suitable for farming.
Wetland or lake	Standing, perennial water and/or wetland	Surveyors often used terms like “marsh”, “swamp”, “bog”, or “lake” to describe these sites. These are not well documented.
Mixed Conifer	Closed canopy forest composed of two or more conifer species.	Surveyors often used the term “heavy forest” and listed multiple species including fir, tamarack, pine, cedar, and hemlock.
Willow, alder, cottonwood, or aspen	This includes any area where willows, alder, cottonwood, or aspen were prominent	These areas were not well documented by most surveys, but did occur and were recorded to some extent.
Level prairie	Bunchgrass prairie	Surveyors often used the term “level prairie” when the land was not rolling and easily tilled.
Cultivated	Any area that had been farmed	Surveyors recorded the presence of a few farms early as 1870.

Table 3: Historic Vegetation Evapotranspiration Rates

Vegetation Type	Evapotranspiration Rate (inches)
Bunchgrass prairie	11
Open Ponderosa pine	17
Open Ponderosa pine on rock	17
Wetland or lake	47
Mixed conifer	22
Cottonwood, alder, aspen, willow	40
Cultivated	16
Notes: Evapotranspiration rates based on Buchanan and Brown (2003)	

Table 4: Historic Vegetation Coverage for the Hangman Creek Watershed

Vegetation Types	Area of Vegetation Types by Watershed (acres)					
	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	Hangman Creek
Bunchgrass Prairie	110,236	13,650	8,999	33,257	662	166,803
Open Ponderosa Pine	32,295	24,175	22,798	40,365	8,554	128,186
Open Ponderosa Pine on Rock	3,583	4,058	6,546	239	449	14,875
Wetland or Lake	0	645	1,995	0	0	2,640
Mixed Conifer Forest	67,976	2,734	0	39,821	6,276	116,796
Cottonwood, alder, aspen, or willow	172	570	0	908	0	1,650
Cultivated	135	114	22	0	0	271

The streams, springs and drainages were densely vegetated with various shrubs and small trees including; hawthorn (*Crataegus*) willows (*Salix*), aspen and cottonwood (*Populus*), alders (*Alnus*), serviceberry (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*). Higher elevations, canyon lands, and northern aspects supported a mix of coniferous forest species including Western Larch (*Larix occidentalis*), Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmanni*), Western hemlock (*Tsuga heterophylla*), and Western red cedar (*Thuja plicata*).

Table 5: Land Use Changes in Hangman Creek (approximately 1870 to 2003)

Sub-watershed	Land Use	Land Uses		Net Change (percent)
		Pre-settlement (acres)	Current (acres)	
California Creek	Agriculture	0	8,801	NA
	Developed	0	332	NA
	Forested	15,257	3,687	(-)75.8
	Rock/Transitional	0	41	NA
	Shrub/Steppe	662	3,018	(+)357
	Wetland or Lake	0	29	NA
Lower Hangman	Agriculture	114	13,697	(+)11,915
	Developed	0	6,554	NA
	Forested	30,820	8,329	(-)73.0
	Rock/Transitional	0	103	NA
	Shrub/Steppe	13,547	16,730	(+)23.5
	Wetland or Lake	1,207	193	(-)84.0
Marshall Creek	Agriculture	21	10,624	(+)50,490
	Developed	0	2,243	NA
	Forested	28,655	13,906	(-)51.5
	Rock/Transitional	0	338	NA
	Shrub/Steppe	8,706	11,032	(+)26.7
	Wetland or Lake	1,930	919	(-)52.4
Rock Creek	Agriculture	0	92,634	NA
	Developed	0	1,524	NA
	Forested	81,062	11,181	(-)86.2
	Rock/Transitional	0	98	NA
	Shrub/Steppe	33,058	8,324	(-)74.8
	Wetland or Lake	902	73	(-)91.9
Upper Hangman	Agriculture	133	149,750	(+)112,494
	Developed	0	2,798	NA
	Forested	102,935	45,335	(-)56.0
	Rock/Transitional	0	1,128	NA
	Shrub/Steppe	109,404	12,271	(-)88.8
	Wetland or Lake	169	140	(-)17.2
Notes:				
1. Agriculture is historic cultivated.				
2. Developed and rock/transitional have no historic equivalent.				
3. Forested is historic open Ponderosa pine, Ponderosa pine on rocks, and mixed conifers.				
4. Shrub steppe is historic bunchgrass prairie.				
5. Wetland or lake is historic wetland or lake and alder, cottonwoods, aspen, or willow groves.				

Agriculture has become the dominant land use for the watershed at over 275,000 acres. This is approximately the pre-settlement prairie and forested areas combined. Overall forestland cover reductions average between 50 to 75 percent for the sub-watersheds with the exception of Rock Creek (approximately 86 percent). The harvest and conversion of

these of forested areas, especially in headwater tributaries, probably had significant impacts to the hydrology of the watershed.

The base flow of Hangman Creek may have been affected by the early land use conversions at the turn of the century. Actual increases of base flows following the removal of forested land have been reported in many different studies (Bates and Henry 1928; Troendle 1983; Van Haveren 1988). However in arid environments with high evapotranspiration rates, such as eastern Washington, these increases may be more dependent upon sufficient summer precipitation.

Local watershed residents have reported that summer flows during the 1940 and 50s were much higher than what is currently observed (SCCD, 1998). This may have been a response to the clearing of forest canopies throughout the watershed. For the months of July through October (1948 – 1959), the USGS records indicate that the average monthly flow was never less than 12 cfs. However, based on the USGS low flow statistics, during the critical base flow period (July – October) for Hangman Creek, there is a 50 percent probability that the 30-day low flow will be less than 12 cfs.

Historical Water Balance

The historical water balance was developed through the application of the pre-settlement vegetative communities for each sub-watershed. The same methodology used by Buchanan and Brown (2003) was applied to calculate a new water balance. The most significant adjustment to the calculation, besides the vegetative cover, was the new evapotranspiration (ET) rates.

The ET rates of pre-settlement times were, on average, greater than the current rates due to the amount and density of the vegetation. One of the major current vegetation land uses is small grains. Small grains have ET rates of approximately 11 inches per year, whereas the previously existing forested areas had ET rates ranging between 17 and 22 inches per year. This change in vegetation type results in an increased water surplus because less water is currently taken up and used by the vegetation than in historic times.

The historical water balance suggests that there was less water during pre-settlement times than what is seen today. The current estimated watershed surplus is 192,854 acre-feet per year. The historical water balance calculations indicated a surplus of only 152,773 acre-feet per year (Table 6). A 40,000 acre-feet per year difference is probably minor, but this data strongly suggests that there was less water historically than there is today.

The increased moisture surplus seems reasonable when one looks at the land use changes that have occurred. In the Hangman Creek watershed, thousands of acres of forest canopy have been lost. This likely resulted in a substantial reduction of snow and rain interception. However, the rate of snowmelt would be increased. The additional snowpack accumulation and the frequent rain on snow events would melt the snow faster and substantially increase the size of peak flows in major flood events. It is during these

major storm events that Hangman Creek suffers severe stream bank and channel damage along with significant sediment transport.

In December of 1996 and January of 1997, heavy snowfall and rains triggered successive flooding events that severely impacted Hangman Creek. The 1997 event recorded a flow of over 21,000 cfs. This was the peak flood of record. The small towns, residential homes, golf courses, and businesses within the floodplain experienced extensive damage. The damage costs for these two recent events totaled over three million dollars.

Sediment transport through the Hangman Creek system is significant, especially during extreme flood events. A cooperative study by the SCCD and USGS (1998-2001) estimated annual sediment discharge (suspended and bedload) ranging from 4,740 to 189,000 tons. The SCCD also estimated the total sediment load from 1906 to 1996 to be approximately 27.6 million tons. These studies illustrate the magnitude of water quality problems in the watershed.

Table 6: Historic and Current Water Balance Parameters and Surplus

Water Balance Sub-Watershed Parameter	Sub-Watershed					Total Hangman Watershed
	Upper Hangman	Lower Hangman	Marshall Creek	Rock Creek	California Creek	
Area (acres)	214,383	45,947	40,359	114,590	15,942	431,221
Precipitation (inches)	22.3	17.8	17.4	19.6	19.9	NA
Historic ET (inches)	15.5	16.2	17.1	17.2	18.7	NA
Current ET (inches)	14.9	15.9	15.6	14.7	19.5	NA
Historic Surplus (acre-feet per year)	121,168	6,051	860	23,125	1,569	152,773
Current Surplus (acre-feet per year)	132,203	7,275	6,054	46,791	531	192,854
Change in Surplus Historic to Current (acre-feet per year)	11,035	1,223	5,194	23,666	-1,037	40,081
Notes:						
1. ET is evapotranspiration.						
2. NA is not applicable.						
3. Evapotranspiration is a weighted value based on percentage of vegetation type for each sub-watershed.						

Soil Erosion and Possible Changes in Erosion Rates

The evaluation of historic soil erosion was done using the NRCS Revised Universal Soil Loss Equation (NRCS Field Office Guide Book). This equation is usually used to predict soil loss from different farm practices and crop rotations. The historic soil loss was based on changes that would affect different factors in the soil loss equation and historic erosion rates. The final estimation of soil loss is based on a percentage of current possible losses.

A percentage is used because the actual RUSLE soil losses for the entire watershed cannot be estimated. The factors that would change in the equation and how the predicted soil losses would also change can be evaluated. The soil loss equation is:

$A = RKLSCP$, where

A is the computed soil loss per unit area, usually expressed in tons per year

R is the rainfall and runoff factor

K is the soil erodibility factor

L is the slope-length factor

S is the slope-steepness factor

C is the cover and management factor

P is the support practice factor

Of all these factors, R, K, L, and S will be approximately the same for both current and pre-settlement conditions. The only conditions that would change are the cover and management conditions and the support practice factors. When these are evaluated, it is assumed that pre-settlement conditions would have been most like the no-till/low-till grass conditions with support practices better than contour farming. The assumed historic conditions are evaluated against current conditions of winter wheat, fallow, peas and spring grain crop rotations with support practices of up and down hill and contour farming.

For the cover and management factor C, the percent decrease in soil loss is approximate:

Percent of current soil loss for C factor = $(0.01/.10) \times 100 = 10$ percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

For the support practice factor P, assuming the pre-development conditions would be approximately half of the contour-farming factor. The current P factor is based on the average of up and down hill and contour farming (approximately 0.70). The percent decrease in soil loss is approximately:

Percent of current soil loss for P factor = $(0.25/.70) \times 100 \sim 37$ percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

The total estimated soil loss would be approximately the reduction in C times the reduction in P, or

Total percent of current soil loss = $(10 \text{ percent})(37 \text{ percent}) = (0.10)(0.37) \sim 4$ percent of the current soil loss from farmland.

This represents a decrease in soil loss rates of approximately 96 percent. Using the PSIAC estimated soil loss from farmland (SCCD, 1994) for the entire Hangman Creek watershed of 176,000 tons, the pre-settlement non-bank erosion soil loss is estimated to have been approximately 7,000 tons per year. As a check on the validity of this

estimation, during recent suspended sediment measurements, the suspended sediment measured by the USGS for water year 2001 was less than 3,500 tons. The 2001 overland flow conditions probably reflect conditions similar to the overland flow on the pre-settlement watershed vegetation as outlined by the section line surveyors.

Another factor resulting in the net increase of water availability may be the effects from the past removal of riparian vegetation. The removal of streamside areas that were once composed of woody, wetland species presumably sequestered and transpired water at a high rate. The removal of vegetative communities may contribute to the current increase in water surplus. This analysis did not reflect the historic condition of riparian vegetation or its conversion to other uses. However, the removal of riparian vegetation along the creeks was a widespread practice of early farmers that was encouraged by the Soil Conservation Service around World War II (Edelen and Allen, 1998).

Current Land Use within the Historic Extent of Prairie (shrub/steppe) Vegetation in Upper Hangman Sub-Watershed

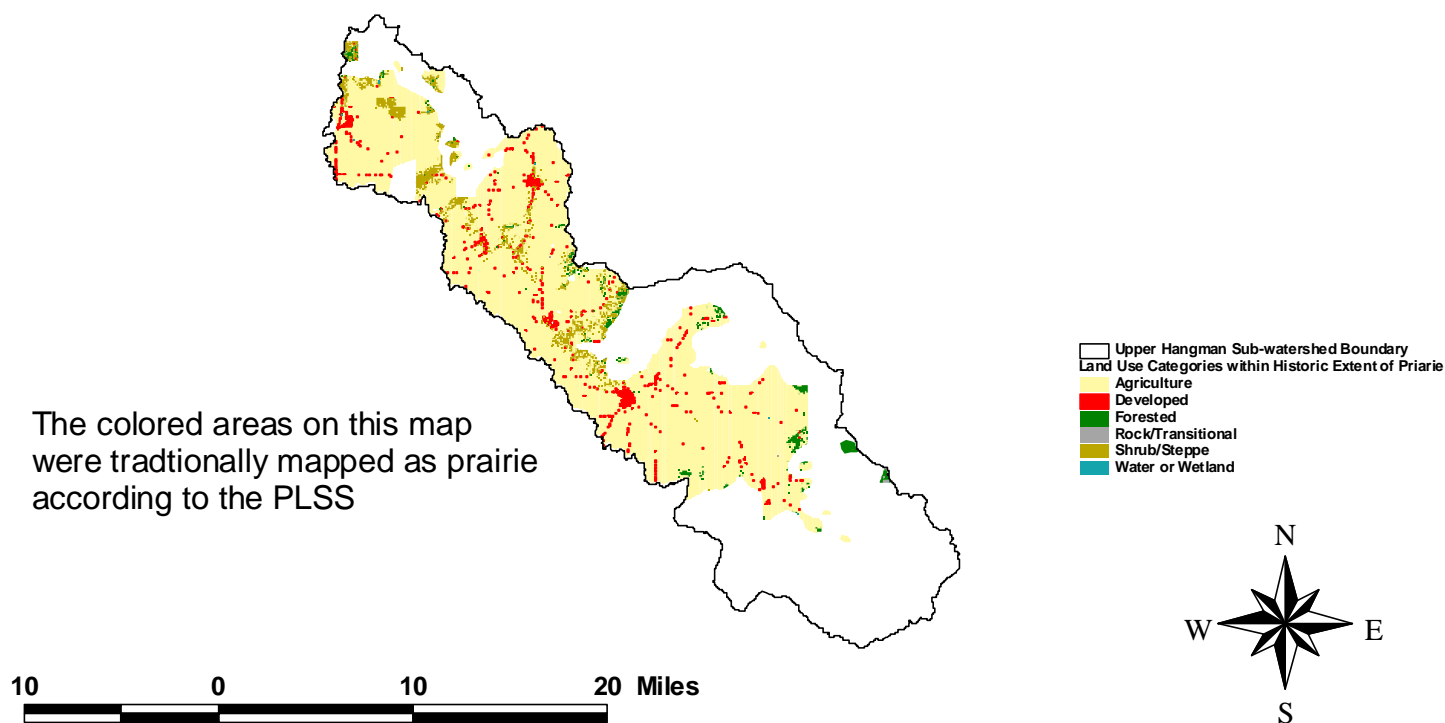


Figure 2

Species list and interpreted terms for plants observed by surveyors

Terms used by Surveyors	Species list as interpreted by SCCD	Comments on observations
“sunflowers”	Arrowleaf balsamroot <i>Balsamorhiza sagittata</i>	Often found in association with Ponderosa pine or bunchgrass prairies
“weeds”	Any herbaceous understory plant	Surveyors who used the term “weeds” did not elaborate on species, use a common names, or describe these plants
“buck brush”	Common snowberry <i>Symphoricarpos albus</i>	“buck brush” is a common name for a similar species found in the southern Midwest of the US that surveyors may have been more common with. They often found this in forested hills of Idaho and grasslands of Washington
“pine grass”	Pine reedgrass <i>Calamagrotosis rubescens</i>	Noted amidst pine stands and prairies
“bunchgrass”	Bluebunch wheatgrass <i>Pseudorogeneria spicata</i> or Idaho fescue <i>Festuca Idahoensis</i>	Found in prairies and as dominant understory in many forested communities described by surveyors
“rye grass”	Basin wild rye <i>Leymus cinereus</i> or <i>Lolium spp.</i>	Rye grass is mentioned in association with other grasses
“service”	Serviceberry <i>Amelanchier alnifolia</i>	Commonly found in grassland and forested communities
“tamarack”	Western larch <i>Larix occidentalis</i>	Tamarack is the common name for Eastern larch (<i>Larix laricina</i>) found in the Northeastern US and was presumably observed as the same species
“rose”	Nutka rose <i>Rosa nootkana</i> or Pearhip rose <i>Rosa woodsii</i>	Found in prairies and forested communities
“willow”	<i>Salix spp.</i> Or Scouler willow <i>Salix scouleriana</i>	Willows were found in both ravines or streams and in forested, upland communities. When found in the upland situation, it is assumed to be Scouler willow
“cherry”	Choke cherry <i>Prunus virgiana</i> or Bitter cherry <i>Prunus emarginata</i>	Cited as an understory plant in forested communities
“thornbush” or “thicket”	Douglas hawthorn (<i>Crataegus douglasii</i>)	Often describe as being in ravines, which is characteristic of Douglas hawthorn

Terms used by Surveyors	Species list as interpreted by SCCD	Comments on observations
“maple”	Rocky mountain maple <i>Acer glabrum</i>	Observed in forested communities as understory
“yellow pine”	Ponderosa pine <i>Pinus ponderosa</i>	Yellow pine is an accepted common name for Ponderosa pine. Old growth Ponderosas were often referred to as “yellow bellies” by pioneers because of the yellowish bark found only on old, large trees.
“red fir” or “fir”	Douglas fir <i>Pseudotsuga menziesii</i>	Found in association with Ponderosa pine and in mixed forests in the upper watershed
“white fir”	Grand fir <i>Abies grandis</i>	Found mostly in the Idaho portions of the upper watershed
“white pine”	Western white pine <i>Abies monticola</i>	Once abundant in northern Idaho, but populations were decimated by white pine blister rust in the early 1900s
“black pine”	Unknown	Observed in Idaho in mixed conifer stands. Possibly young Ponderosa pines, which often exhibit black bark.
“spruce”	Engelmann spruce <i>Picea engelmanni</i>	Found only in the upper reaches of watershed in Idaho
“cedar”	Western red cedar <i>Thuja plicata</i>	Observed in drainages and northern facing slopes of hills amidst mixed conifers
“hemlock”	Western hemlock <i>Tsuga heterophylla</i>	Often found with western red cedar in draws or north facing slopes
“cottonwood”	Black cottonwood <i>Populus trichocarpa</i>	Often found along creeks
“aspen”	Quaking aspen <i>Populus tremuloides</i>	Often observed adjacent to wetlands or creeks
“alder”	Thinleaf alder <i>Alnus incana</i> Or Red alder <i>Alnus rubra</i>	Often found in ravines, but usually only mentioned in the General Description of a section
“hazel”	Unknown	“Hazel” was cited as an understory plant in many forested areas. Possibly, the surveyor confused red alder or thinleaf alder for hazel alder <i>Alnus serrulata</i> found in throughout the Midwest and Eastern states

Sub-watershed Evapotranspiration Calculations

Upper Hangman Sub-Watershed ET Calculations

Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	108,730	0.50	71.0	11.0	5.7
Open Ponderosa	31,854	0.20	42.0	17.0	2.6
Ponderosa on Rock	3,534	<0.01	42.0	17.0	0.3
Mixed Conifer	67,036	0.30	42.0	22.0	7.0
Cottonwood, alder, aspen, willow	169	<0.01	91.0	40.0	0.0
Cultivated	133	<0.01	83.0	16.0	0.0
Total	211,456	1.0	NA	NA	15.6

Rock Creek Sub-Watershed ET Calculations

Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	33,058	0.29	199.4	11.0	3.2
Open Ponderosa	40,123	0.35	242.0	17.0	6.0
Ponderosa on Rock	238	0.00	1.4	17.0	0.0
Mixed Conifer	39,582	0.35	238.7	22.0	7.6
Cottonwood, alder, aspen, willow	902	0.01	5.4	40.0	0.3
Total	113,903	1.00	NA	NA	17.1

California Creek Sub-watershed ET Calculations

Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	661	0.04	71.0	11.0	0.5
Open Ponderosa	8,535	0.54	42.0	17.0	9.1
Ponderosa on Rock	448	0.03	42.0	17.0	0.5
Mixed Conifer	6,262	0.39	42.0	22.0	8.7
Total	15,906	1.00	NA	NA	18.8

Lower Hangman Creek Sub-watershed ET Calculation

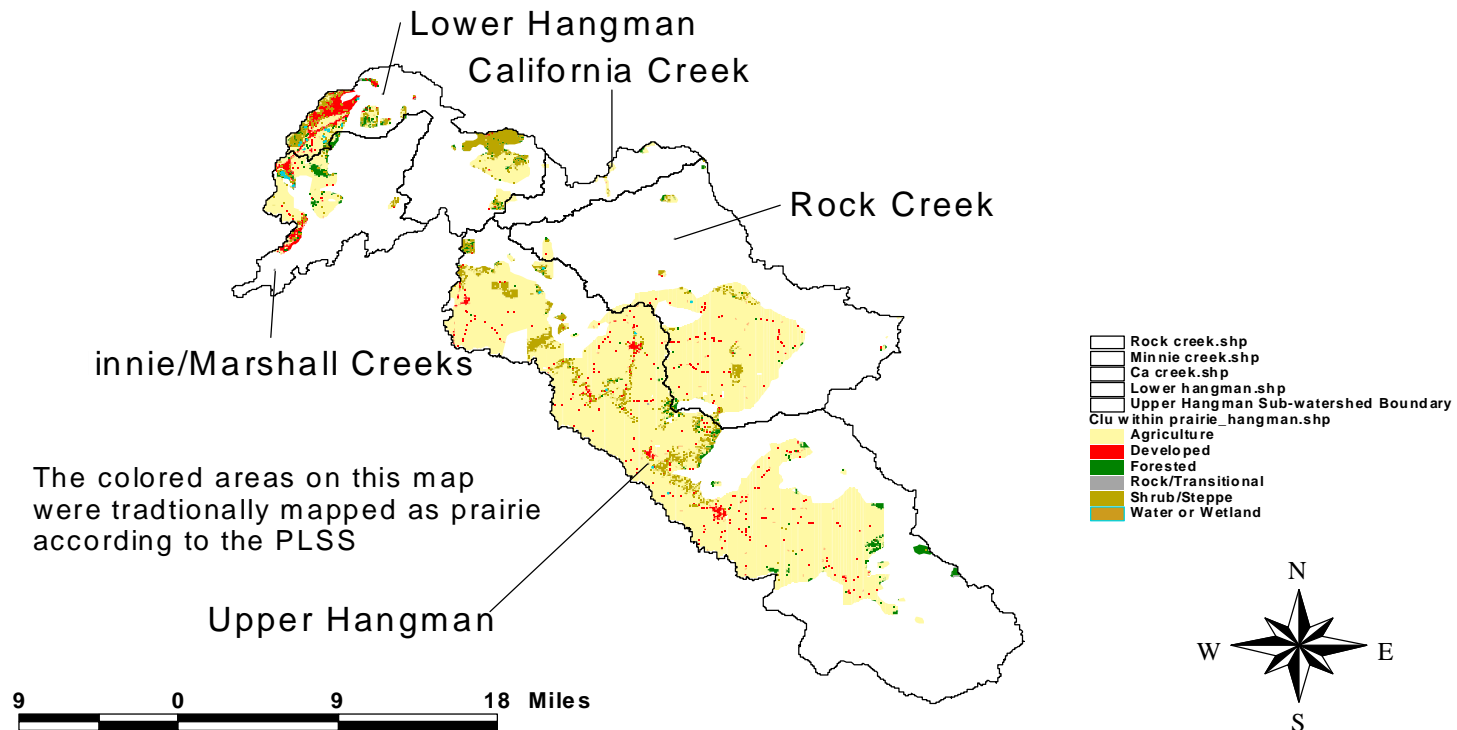
Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	13,547	0.30	71	11	3.3
Open Ponderosa	23,993	0.53	42	17	8.9
Ponderosa on Rock	4,027	0.09	42	17	1.5
Mixed Conifer	566	0.01	91	40	0.5
Cottonwood, alder, aspen, willow	2,714	0.06	42	22	1.3
Cultivated	114	0.00	83	16	0.0
Wetland/Lake	641	0.01	11	47	0.6
Total	45,602	1.00	NA	NA	16.1

Minnie/Marshall Creek Sub-watershed ET Calculation

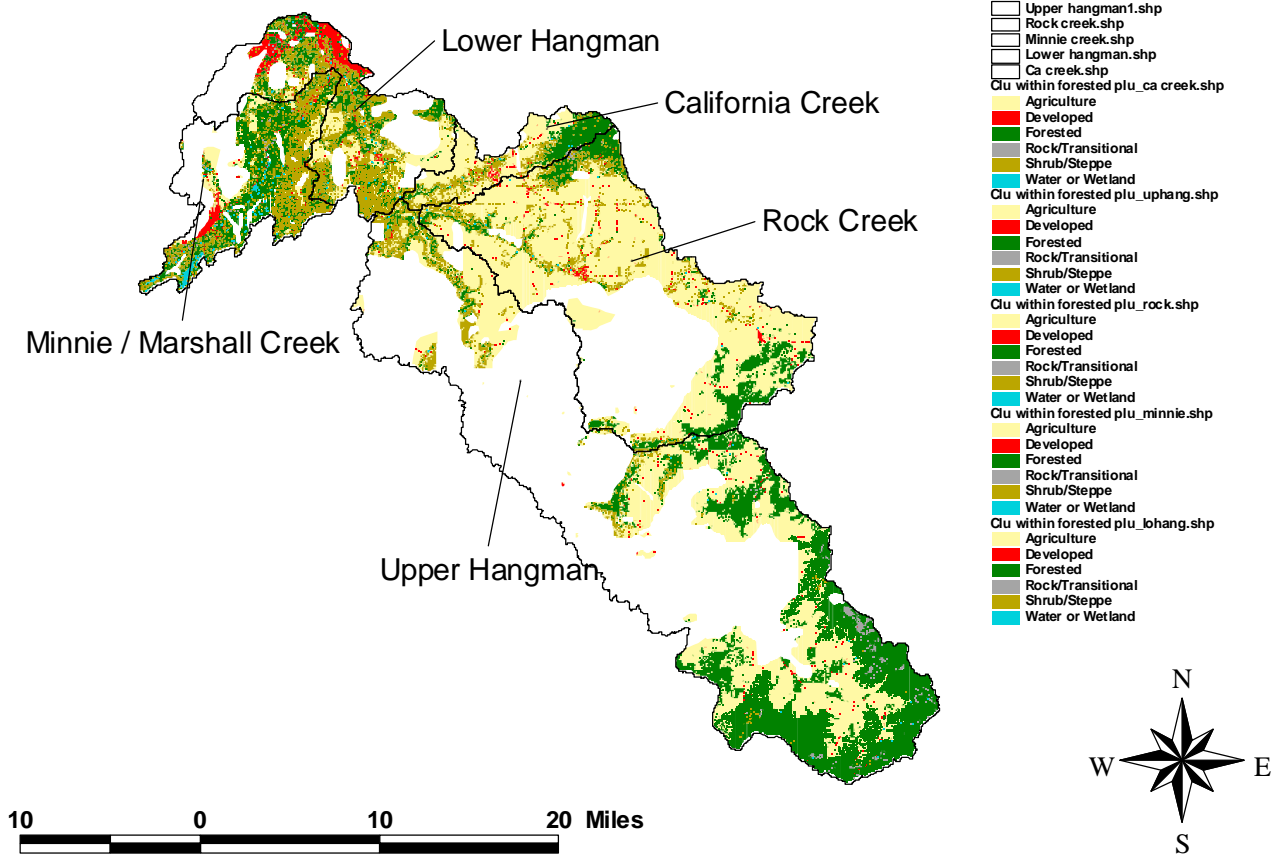
Historic Vegetation Type	Area (acres)	Proportion (percent)	USGS Land Use Code	ET Rate (inches)	Weighted ET
Prairie	8,706	0.22	71	11	2.5
Open Ponderosa	22,056	0.56	42	17	9.6
Ponderosa on Rock	6,333	0.16	42	17	2.8
Cultivated	21	<0.01	83	16	0.0
Wetland/Lake	1,930	0.05	11	47	2.3
Total	39,046	0.99	NA	NA	17.2

Current Land Use Maps Depicting Conversion of Shrub/Steppe and Forested Historic Vegetation Types

Current Land Use within the Historic Extent of Prairie (Shrub/Steppe) Vegetation in the Hangman Creek Watershed



Current Land Use within Historic Extent of Forested Areas in Hangman Creek Watershed



Tabular Data Generated by ArcView 3.2 to Illustrate Changes in Acres of Pre-Settlement Vegetation to Current Land Use

Changes in Land Use by Sub-Watershed				
Sub-Watershed	Land Use	Pre-Settlement (acres)	Current (acres)	Net Change (acres)
California Creek	Agriculture	0	8801	8801
	Developed	0	332	332
	Forested	15257	3687	-11570
	Rock/Transitional	0	41	41
	Shrub/Steppe	661	3018	2357
	Water or Wetland	0	29	29
Lower Hangman	Agriculture	114	13697	13583
	Developed	0	6554	6554
	Forested	30820	8329	-22491
	Rock/Transitional	0	103	103
	Shrub/Steppe	13547	16730	3183
	Water or Wetland	1207	193	-1014
Marshall Creek	Agriculture	21	10624	10603
	Developed	0	2243	2243
	Forested	28655	13906	-14749
	Rock/Transitional	0	338	338
	Shrub/Steppe	8706	11032	2326
	Water or Wetland	1930	919	-1011
Rock Creek	Agriculture	0	92634	92634
	Developed	0	1524	1524
	Forested	81062	11181	-69881
	Rock/Transitional	0	98	98
	Shrub/Steppe	33058	8324	-24734
	Water or Wetland	902	73	-829
Upper Hangman	Agriculture	133	149750	-149617
	Developed	0	2798	-2798
	Forested	102935	45335	57600
	Rock/Transitional	0	1128	-1128
	Shrub/Steppe	109404	12271	97133
	Water or Wetland	169	140	29

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